EPA APPROACH FOR THE DIAGNOSTIC EVALUATION OF P.O.T.W. PERFORMANCE

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INTRODUCTION

The United States Environmental Protection Agency (EPA), Region IV Environmental Services Division (ESD) in Athens frequently receives requests from the Regional Office in Atlanta and state environmental agencies to conduct "diagnostic evaluations" of Publicly Owned Treatment Works (POTWs). Diagnostic evaluations are conducted to:

(1) evaluate the design, operations, and management factors limiting treatment system performance, and/or

(2) determine the need for treatment system modifications or additions.

The quality of effluents from POTWs directly influences the water quality in Georgia's surface waters. The diagnostic evaluation has been proven an effective tool for evaluating POTWs, and the DE findings and recommendations often form a basis for decisions made by EPA in the management of POTW compliance and construction grants programs.

DIAGNOSTIC EVALUATION PREPARATION

Study Objectives

Diagnostic evaluations are designed to meet the objectives of the requesting EPA program or state environmental agency. The diagnostic evaluation may be requested in conjunction with a case development effort by the Facilities Performance Branch (FPB) if a POTW has been exceeding the effluent limits contained in the NPDES permit. A diagnostic evaluation may also be requested by the Facilities Construction Branch (FCB) to evaluate a request by a municipality for additional funding for either modification or replacement of an existing unit process.

The specific objectives of the DE may include:

- characterization of the raw wastewater and final effluent;
- evaluation of unit process performance via visual observations and sampling between processes, data review and process control testing;
- determination of unit processes operating parameters (e.g. mean cell residence time for activated sludge systems, surface overflow rate for clarifiers, etc.);
- review of operations and management via interviews with key operations and management personnel;
- evaluation of the NPDES self-monitoring program including sampling, flow measurement, records and reports, and laboratory procedures; and
- development of recommendations for improved performance and reliability.

Study Plan Preparation

"Study Plans" for each diagnostic evaluation are developed to insure that the objectives of the DE are in accordance with the goals of the requesting office. Diagnostic evaluations may require the collection of samples including influent and effluent wastewaters, samples collected within the treatment process that isolate specific unit processes for performance assessment, and wastewater sludges. Water quality samples from the receiving waters may also be included in the study plan. The diagnostic evaluation study plan will outline the location and types of samples to be collected, as well as the required process control testing to be completed during the evaluation. All sampling is conducted in accordance with the Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual (US-EPA, 1986).

Samples are typically analyzed for conventional parameters such as five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), ammonia (NH_3), and total phosphorus (T-P). Samples may also be analyzed for extractable and purgeable organic compounds and metals if industrial wastewaters are suspected of influencing the quality of the final effluent or wastewater sludges.

Review of Historical Data/POTW Information

Prior to conducting the DE the EPA staff will review available historical data and POTW information. The EPA Handbook: Improving POTW Performance Using the Composite Correction Program Approach is often used as a source for checklists of unit sizes, process information, and management items (Hegg, Schultz, and Rakness, 1984). The Composite Correction Program approach is used by many state agencies to evaluate POTWs and determine what steps are neccesary to bring them into compliance.

Historical data typically includes influent and effluent wastewater characteristics, "process control test" results, and records of operating parameters such as mean cell residence time (MCRT) or surface overflow rate. POTW operating logs, pretreatment reports, and EPA compliance files, including the monthly Discharge Monitoring Reports (DMRs), may also be consulted prior to the study. Generally the data recorded by the POTW staff on monthly operating reports (MORs) are more helpful in assessing plant operations than the monthly discharge data reported to EPA. The POTW Superintendent is normally contacted prior to the diagnostic evaluation and requested to provide historical data and information on suspected design deficiencies. The EPA Handbook: Identification and Correction of Typical Design Defifeciencies at Muncipal Wastewater Treatment Plants lists typical design problems and recommended corrective actions (Dougherty, 1982).

Often a review of the historical data will provide insights concerning the factors that are influencing POTW performance. The operations staff may have selected a target mixed liquor suspended solids (MLSS) concentration as a "method of control" for the activated sludge system. The MLSS results may be compared to the settleability of the mixed liquor and the resulting effluent quality to determine if the target MLSS value is satisfactory. By evaluating the MLSS concentrations, sludge settleability and treatment system performance, EPA investigators can compare the method of control utilized by the staff to the performance of the POTW.

EPA investigators encourage the use of time-series "trend charts" with a five-day moving average to evaluate POTW data. Unfortunately, many POTW staffs are not adequately analyzing the data they have collected.

Process Control Testing

EPA investigators routinely conduct process control tests during a diagnostic evaluation at activated sludge POTWs to provide information on the quality of the mixed liquor in the biological process (biological activity, settling characteristics). The EPA Process Control Manual: Aerobic Biological Wastewater Treatment Facilities outlines the use of process control testing for evaluating POTW performance (US-EPA, 1977). The ESD in Athens has also compiled much of the information on process control testing into a handbook entitled Introduction to Activated Sludge Process Control Testing which is available upon request (US-EPA, 1981). Process control tests that are typically conducted during a diagnostic evaluation are included in Table 1.

TABLE 1 PROCESS CONTROL TESTS.

Test Type	Objective
Settlometer	Simulates mixed liquor settleability in final clarifiers.
Centrifuge	Estimates aeration basin MLSS concentrations, MLSS balance between basins, and the flow balance between return activated sludge (RAS) lines.
Oxygen Profile	Measures oxygen levels in aeration basins.
Oxygen Uptake	Estimates activity of mixed liquor and influence of industrial wastewaters.
Microscopic Exam	Assesses protozoan community as an indicator of the biological activity in an activated sludge system.
Blanket Depth	Measures sludge blanket depth (SBD) in clarifiers.

Evaluation of Operating Parameters

Unit process operating parameters are calculated to determine if the hydraulic and organic loadings are within the recommended range for each unit. Projected loadings are often calculated to determine the need for unit process modification or additions. The recommended operating parameter ranges are usually listed in the POTW Operations and Maintenance Manual or standard wastewater engineering textbooks (Metcalf and Eddy, Inc., 1979, Benefield and Randall, 1980). The operating parameters typically evaluated as part of a diagnostic evaluation are listed in Table 2.

TABLE 2 POTW OPERATING PARAMETERS.

Operating Parameter	Units
Aeration Basins	
Mixed Liquor Suspended Solids	MLSS (mg/l)
MLVSS (Volatile)	MLVSS (mg/l)
Solids inventory	lb MLVSS
Detention time	hr
Food:Microorganism ratio (F:M)	
Mean Cell Residence Time (MCRT)	days
Organic loading	lb/1000 cu ft/d
Trickling Filters and RBCs	
Hydraulic loading	gal/sq ft/day
Organic loading	lb BOD_5/1000 cu ft/d
Recirculation ratio	% of POTW flow
Final Clarifiers	
Detention time (including Q_{RAS})	hr
Surface overflow rate	gal/sq ft/day
Solids loading	lb/sq ft/day

CASE HISTORY

Performance Based Request

The Environmental Services Division was requested to conduct a diagnostic evaluation at a 14.0 mgd (design) pure oxygen-activated sludge POTW that had violated the BOD_5, TSS, and NH_3 limits of the NPDES permit for two quarters. Twenty-four hour composite samples were collected at six locations throughout the POTW and analyzed for conventional parameters, as well as extractable organic compounds and metals because of suspected industrial interferences. Grab samples were analyzed for purgeable organic compounds, phenol, oil and grease, and cyanide. Process control tests were conducted and interviews with key operations personnel were completed during the four-day study. The major findings were as follows:

- The POTW exceeded the limits of the NPDES permit for BOD_5 and NH_3 during the evaluation.
- A by-pass of the treatment system was not represented by the data reported on the monthly discharge monitoring report.
- Sidestream returns from the sludge handling process accounted for 28 percent of the BOD_5 loading to the activated sludge process.
- Although the staff conducted sludge settleability tests, dissolved oxygen profiles, and microscopic examinations, the data were not adequately used to evaluate performance or modify the "Constant MLSS" method of control.
- Process control tests and soluble BOD_5 results showed the mixed liquor was inactive with poor settling characteristics.
- The low pH (5.9 to 6.2 S.U.) and short detention time in the pure oxygen basins probably contributed to the low nitrification rate.
- The metals and organic compound concentrations were below the levels reported to be inhibitory or toxic to the activated sludge process.

The EPA recommended that:

- The by-pass flow be continuously monitored for flow and sampled when in use.
- The sidestream returns be monitored to determine the effect on performance.
- The POTW staff increase their efforts in the area of process control data assessment and interpretation to evaluate the relationship between key operating parameters (MCRT) and system performance (soluble BOD_5 removal and nitrification rates).
- The solids inventory should be adjusted to obtain an MCRT that provides for adequate soluble BOD_5 removal and nitrification, as well as good settling characteristics.

Although EPA requested the diagnostic evaluation at this POTW, the respective state agency used the report findings and recommendations to negotiate a reasonable consent order with the municipality.

CONCLUSIONS

The diagnostic evaluation has proved to be a valuable tool for providing information on the current/projected performance of POTWs. EPA and state environmental agencies have effectively used the recommendations and findings in diagnostic evaluation reports to negotiate reasonable and equitable compliance agreements, and to render fair determinations on grant requests.

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